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Great Lakes Update

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1996 Annual Summary

Great Lakes water levels continued to follow their general seasonal patterns while reaching levels that were significantly higher than those of 1995.

Precipitation and Temperature

Lake levels follow a seasonal pattern, normally rising in the spring, peaking in the summer and declining in the fall to a low during the winter. This pattern is shown by the long-term average shown on the lake hydrographs contained in the *Monthly Bulletin of Lake Levels for the Great Lakes*.

The severe cold that affected the United States during late January and early February 1996 was of historic proportions in the Upper Great Lakes Basin. Daily low temperature records were set at various locations in the region. This may have been one of, if not the, coldest weather events of the 20th century. Significantly higher than normal snowfall occurred during the 1995 - 1996 winter months. The subsequent increased snowmelt, when combined with higher-than-normal amounts of precipitation over the Great Lakes basin, resulted in above-average supplies. These conditions resulted in lake levels rising to above average values starting in April, 1996, and remaining above average for the remainder of 1996. During the spring, summer and fall, temperatures remained in the normal range.

Precipitation over the Great Lakes for 1996, was above normal, based on preliminary records for the U.S. National Weather Service and Canadian Atmospheric Environment Service. Dry periods were experienced in March, May, August, and November, with the remaining months being wetter than normal. Total basin-wide precipitation for 1996 was 36.8 inches, about 4.5 inches above normal. Figure 1 compares the monthly precipitation for 1995 and 1996 to the long term average for the entire basin.

Lake Levels

The *Monthly Bulletin of Lake Levels for the Great Lakes*, which fosters this annual summary, graphically shows the fluctuations of water levels on the Great Lakes for the years 1995 and 1996. During 1996, Lake Superior followed its seasonal cycle. Levels started the year at 601.61 feet, about 1 inch above average, and remained at or near the long-term average into April when levels started to rise. Because of higher than normal supplies, Lake Superior began to rise faster than normal in April. Levels reached their highest point in August

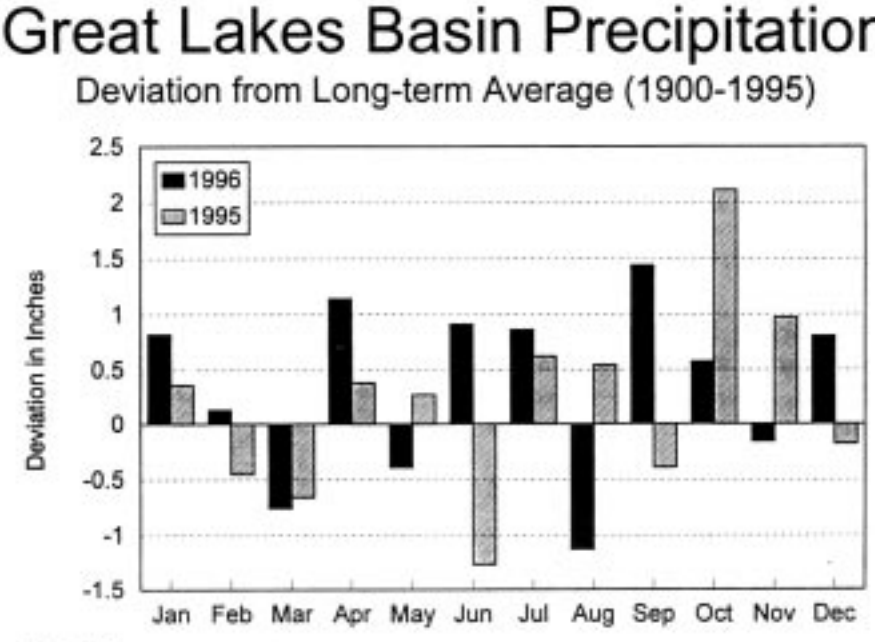

Figure 1

and September, at 603.02 feet, about 9 inches above average. At the end of December, Lake Superior's water level was at 602.40 feet, about 7 inches above the December long-term average.

Lakes Michigan-Huron levels generally followed their seasonal cycle, starting the year at 578.61 feet, near the long-term average. Levels remained at or near the long-term average until April, when they started to rise. Above normal precipitation resulted in above average levels throughout the year. Levels reached a high of 580.28 feet in August, about 10 inches above the August long-term average. Lakes Michigan-Huron ended the year at 579.99 feet, about 15 inches above the December long-term average.

Lake St. Clair was affected by ice jams in the St. Clair River in January and April, resulting in depressed levels of 572.77 feet (about 10 inches below average) and 572.57 feet (about 21 inches below average), respectively. Starting in April levels rose and remained above-average through 1996, reaching a high of 576.12 feet, about 17 inches above average, and ending the year at 575.52 feet, about 20 inches above the December long-term average.

Lake Erie water levels generally followed the usual seasonal cycle, starting the year at 571.39 feet, about 7 inches above the January long-term average. April saw levels start to rise, reaching a June peak of 573.06 feet, about 14 inches above the June long-term average. Lake Erie ended 1996 at a level of 572.60 feet, about 22 inches above the December average.

Lake Ontario generally followed its seasonal cycle, starting the year at 244.75 feet, about 2 inches above the January long-term average. Levels started rising in April, reaching a peak in both May and June of 246.85 feet, about 9 inches above average. The year ended with the Lake Ontario level at 245.31 feet, about 10 inches above the December long-term average.

Storms

The Great Lakes Storm Damage Reporting System (GLSDRS) was developed in 1993 by the Chicago District, Corps of Engineers. The system monitors hydrological and meteorological data (water levels, wave heights, wind speed and wind direction) in order to identify storm activity on the Great Lakes. Subsequent telephone surveys are conducted to collect damage information for the impacted areas. During the 1996 calendar year 22 telephone surveys were conducted yielding 1,116 interviews. Those interviewed were selected randomly from a qualified population of 10,622 in the counties which are surveyed. Development and use of the system was presented in *Great Lakes Update* issues No. 104 (March, 1994), No. 113 (December, 1994) and No. 121 (August, 1995). Damages reported to structures, contents, vehicles, landscaping, shore protection, docks, boats, etc., were estimated at about $140,800. GLSDRS samples approximately 10% of the riparian property owners in affected areas; thus, the total damages for 1996 in the study area are estimated at about $1,341,000 when applied to all of the shoreline areas affected by the storms. The two day period for October 30 and 31, 1996, showed particularly high storm activity. Five storm surveys were conducted, representing 285 interviews. During this period, riparians along the west coast of Michigan (Lake Michigan) and in Wisconsin (Lake Superior) were affected. Coast Guard stations on Lake Michigan reported 20-23 knot winds from a westerly direction, with wave heights of 6-10 feet. Figures 2 and 3 show storm activity on October 30, 1996, at Grand Haven Harbor and Muskegon Harbor.

Lake Superior Regulation

In 1996 the International Lake Superior Board of Control (ILSBC) continued to use Regulation Plan 1977-A and Criterion (c) of the Order of Approval as the primary basis for determining Lake Superior outflows. Criterion (c) states that when the monthly mean level of Lake Superior is below 601.7 feet (IGLD 1985), the outflow cannot be greater than that which would have occurred at the same elevation under the outflow conditions which prevailed in 1887. Criterion (c) applied in the January

Figure 2: Grand Haven Harbor -- October 30, 1996

Figure 3: Muskegon Harbor area -- October 30, 1996

through April period. On occasion other factors will influence the setting of outflows, as they did this past year.

During 1996 the Edison Sault Electric Company continued repair work in the intake canal of their hydropower plant on the St. Marys River. This project, which was completed in September, 1996, required reduced flows through the plant during the summer months. This decreased the plant's ability to release water from the lake. Continued renovation of the generating units at the U.S. Government hydropower plant at the St. Marys Canal (Soo Locks) also reduced the overall outflow capacity of the hydropower plants in 1996.

Flow changes resulting from the monthly regulation of Lake Superior are accomplished by varying the amount of water allocated to hydropower production, and, when necessary, by opening or closing gates in the Compensating Works at the head of the St. Marys Rapids.

Starting in May, 1996, the U.S. Army Corps of Engineers and Great Lakes Power, Limited, in Canada, resumed scheduled repairs to the Compensating Works.

Construction on the Canadian portion of the Compensating Works was completed in August, 1996 and the work on the U.S. portion was completed in September. During the construction period, the International Joint Commission authorized outflows that were less than those called for by Plan 1977-A. This was done to ensure worker safety during repairs. Outflows were restricted by setting the control dam gates at 2 gates open (instead of 4) in May and June, and 3 gates open in July and August (instead of 4 and 7 respectively).

The number of open gates was increased to 4-5/6, upon completion of the Canadian work in late August; and to 16 (when the U.S. work was done) in late September. During the summer period of restricted outflows, Lake Superior levels rose about 2-1/2 inches higher that they would have if Plan 1977-A had been applied strictly. The 16 gates open setting was maintained through November. This action resulted in a corresponding drop in the downstream water level of about 1-1/2 inches on Lakes Michigan-Huron, and negligible effects on Lakes St. Clair and Erie.

The International Joint Commission approved closure of the Compensating Works gates to a setting of 1/2 gate open for the period August 10-12, 1996, in order to accommodate the Great Lakes Fishery Commission's sea lamprey control study in the St. Marys River. The effect of this action on the Lake Superior water level was negligible.

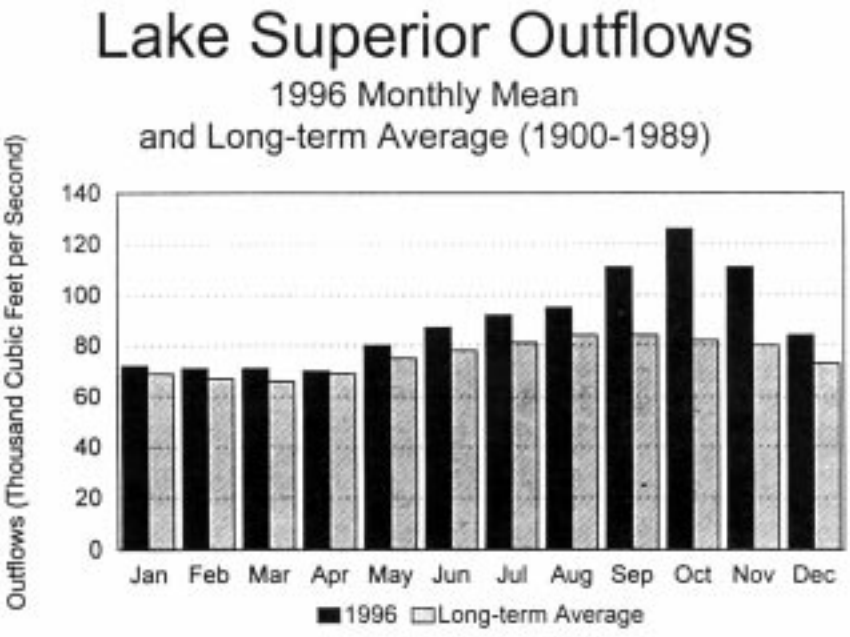

Figure 4

The December outflow was as specified by Plan 1977-A. Figure 4 compares the monthly Lake Superior outflows in 1996 with the long-term average flows. During 1996, except for the August through November period when all 16 gates were open, an additional 530 cfs flow of water was discharged through the northern most gate (Gate No. 1). During the period December, 1996, though April, 1997, Gate No. 1 will be maintained at a 1/2 open setting. This will satisfy the water requirements for the fish habitat in the Rapids.

Lake Ontario Regulation

The winter of 1995-96 arrived early, with very cold temperatures extending from early November into December, 1995. The cold temperatures which extended into early 1996 produced a complete ice cover in the international reach of the St. Lawrence River by mid-January. The ice cover did not cause difficulties to Lake Ontario outflow regulation. Figure 5 shows a comparison of 1996 monthly outflows with ther long-term average monthly outflows.

Lake Ontario reached its seasonal low level of 244.59 feet on January 9. A mid-January thaw with three days of very mild temperatures and rain melted much of the snow on the Lake Ontario basin. The Lake Ontario level rose rapidly in the second half of January. Levels changed very little from February until mid-April, and then rose rapidly through the end of May to the year's peak level of 246.85 feet on May 24. The lake stayed very close to this level throughout the month of June; it was approximately 8 inches above average but about 5 inches below the maximum level set by the lake's regulation plan, 1958-D.

Levels declined gradually after June for the rest of the year, although the decline was halted somewhat in the September - November period due to very high water supplies to the lake. Lake Ontario ended the year at 245.31 feet, some 10 inches above average.

The outflow of Lake Ontario is regulated using the Moses-Saunders Powerhouse and Long Sault Dam spillway in the St. Lawrence River near Cornwall, Ontario and Massena, New York. Plan 1958-D specifies weekly outflows based upon Lake Ontario's levels and trends in water supplies. The regulation plan helps prevent water level extremes, both upstream and downstream of the regulation structures, and it attempts to balance the interests of shoreline property owners, commercial navigation and hydropower interests.

Outflow regulation is overseen by the International Joint Commission's (IJC) International St. Lawrence River Board of Control. In normal operations the Lake Ontario outflow is the amount specified by the regulation plan. However, the Board has some discretionary authority to direct flow deviations from the regulation plan to meet certain objectives. These objectives include providing benefits or relief from adverse impacts associated with water level and flow fluctuations to certain interests, provided that such deviations would not harm other interests. In recent years the Board has also taken into consideration the needs of additional interests, such as recreational boating and the environment, in making its regulation decisions.

During 1996 the Board made a number of deviations in response to the changing conditions in the Lake Ontario - St. Lawrence River system.

Favorable ice conditions on the St. Lawrence River during the winter of 1995-96 resulted in very little restriction to the river flows. As a result outflows higher than those specified by the regulation plan were released in January and February as a part of normal winter operations. The over- discharges, equivalent to about a 1 inch lowering on Lake Ontario, were subsequently offset by flow reductions in April and May.

During the period April 23 through May 17, the Lake Ontario outflows were reduced to below those specified by the regulation plan to prevent flooding on Lake St. Louis, a portion of the St. Lawrence River near Montreal, during the Ottawa River freshet. Until the arrival of the Ottawa River freshet, water levels on Lake St. Louis and areas downstream were low, and there was a concern that the continued low levels would

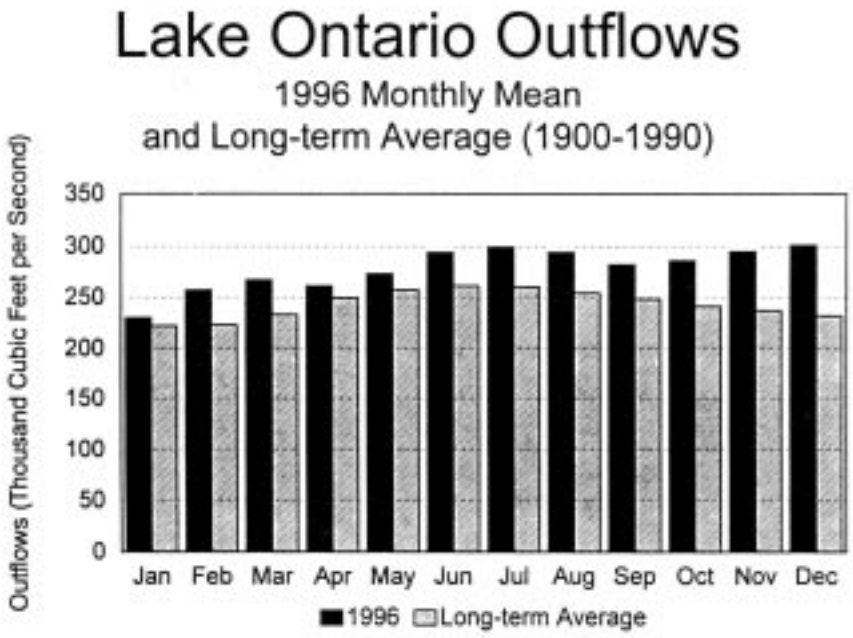

Figure 5

have an adverse impact on fish spawning on Lake St. Louis and other areas downstream. These concerns were eliminated by abundant rain in late April in the Lake Ontario and Ottawa River basins.

At its meeting on June 4 the Board decided to release outflows higher than those specified by Plan 1958-D, since Lake Ontario was at that time about 7 inches above average. However, between August 12 and September 6, flows below regulation plan took place in order to prevent excessively low levels on Lake St. Lawrence, a portion of the river just upstream of the Moses-Saunders Powerhouse. These low levels, a product of the high outflows through the powerhouse, were affecting recreational boaters on Lake St. Lawrence.

Beginning in mid-September, the Board directed that maximum possible outflows be resumed in light of continued above-average levels on Lake Ontario and the upper lakes. However, similar to conditions in August, the high outflows again caused low levels on Lake St. Lawrence. The problem was compounded by strong easterly winds. As a result, Lake St. Lawrence water levels continued to decline, and the Board again made a number of short-term flow reductions until early December. These reductions were necessary to prevent Lake St. Lawrence levels from falling below the minimum for commercial navigation.

As a result of the Board's strategy to release high outflows, 231,000 cfs-weeks of positive deviations were accumulated by the end of the year, which are equivalent to a reduction of Lake Ontario's level by about 8 inches.

In addition to its regulation operations, the Board continued to assess two alternate regulation plans in order to examine potential improvements to Lake Ontario regulation. This 3-year assessment began in early 1994. One plan, called Plan 35-P, is a product of the IJC Levels Reference Study completed in 1993 and is a modified version of the current regulation plan. The other plan, called the Interest Satisfaction (IS) Model, was independently developed and uses an optimization technique that attempts to achieve the best possible compromises among all interests. An evaluation of the 3-years of data from the two alternative regulation plans will start in early 1997, with completion sometime during the summer of 1997. Since the evaluation of the plans is within the existing regulation criteria specified by the International Joint Commission, improvements resulting from any of the plans is expected to be small.

In 1995 the St. Lawrence Board was also requested by the IJC to prepare a scope of work of the studies that would be required to update the Lake Ontario regulation criteria. This request was in response to the 1993 Reference Study report which recommended, among other things, that new regulation criteria be added to consider the needs of the recreational boating and environmental interests. In early 1996 the Board submitted a scope of work to the IJC.

Meetings With The Public

March 19, 1996, the International Niagara Board of Control held a public meeting at Buffalo, New York.

June 3, 1996, the St. Lawrence River board of Control held a public meeting in Watertown, New York. At the meeting the Lake Ontario shore property owners and area elected officials expressed concern with high water levels on Lake Ontario and ongoing erosion problems. On the other hand, recreational boaters and marina operators in eastern Lake Ontario and the Thousand Islands area of the St. Lawrence River expressed a preference for higher levels.

The International Lake Superior Board of Control held a public meeting on June 18, 1996, at Paradise, Michigan. Attendees expressed their concerns about high lake levels and shoreline erosion.

Commercial Navigation

As of the end of 1996 tonnage passing through the Soo Locks at Sault Ste. Marie, Michigan was only 0.4% below the comparable 1995 tonnage. United States and Canadian vessels carried about 55 and 16 million short tons of cargo respectively, while foreign vessels carried about 4 million short tons. Foreign cargo traffic was up about 26.3% over comparable 1995 traffic. Through November, 1996, a total of 3,930 cargo vessels had transited the locks, as compared to 3,975 passages the previous year. Of these, 2,332 passages were U.S.-flagged vessels, 1,173 were Canadian-flagged, and 425 were foreign vessels (ocean-going or "salties"). In addition to the cargo vessels, there were also 5,947 transits by other types of vessels, such as pleasure craft, tour boats, Coast Guard, and scientific research vessels. The Corps of Engineers has the authority to keep the locks open until January 15, 1997, should shipping interests request it.

According to the St. Lawrence Seaway Development Corporation's preliminary figures through the end of November, 1996, 34.5 million metric tons (MMT) of cargo moved through the Lake Ontario-Montreal section of the Seaway. This was 1.3 MMT less than in 1995. As of the end of November, 1996, the total vessel transits were 2,349 (1,456 lakers and 983 ocean vessels), as compared to 2,557 (1,688 lakers and 869 ocean vessels) in 1995.

Seaway officials reported preliminary information on a number of individual cargoes as of the end of November 1996, including: iron ore (up 4% to about 10.7 MMT); grain (down 19% to about 10.6 MMT); coal (down 43% to about 0.5 MMT); and petroleum

products (up 9% to about 1.0 MMT).

1996 Great Lakes Updates

Regular monthly publication of the *Great Lakes Update* ceased with the September, 1995, issue, No. 122. During 1996 the *Great Lakes Update* was published in January, the "1995 Annual Summary", issue No. 124; and again in November, "Great Lakes Water Levels Rise in 1996", issue No. 125. Future issues of the *Great Lakes Update*, starting with this "1996 Annual Summary" , will be published on a quarterly basis dealing with Great Lakes topics of current interest. Should Great Lakes conditions require it, interim issues may be published.

General Notes:

All elevations shown in this article are referenced to the IGLD 1985 datum.

Information about the Great Lakes is available on the World Wide Web. The Internet address for the Detroit District's Home Page is as follows:

http://sparky.nce.usace.army.mil

Information is updated monthly.